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PATENT SPECIFICATION 1,118,607

DRAWINGS ATTACHED.

1,118,607

Date of Application and filing Complete Specification: 21 July, 1966. No. 32784/66.

Application made in United States of America (No. 515,019) on 20 Dec., 1965.

Complete Specification Published: 3 July, 1968.

Index at Acceptance:—B8 P(6H2X, 6R1); B5 A(1R14B, 1R14C1X, 1R100, 9); B6 JA2.

Int. Cl.:—B 65 d 1/36.

COMPLETE SPECIFICATION.

SPECIFICATION NO. 1,118,607

By a direction given under Section 17 (1) of the Patents Act 1949 this application proceeded in the name of AMXCO INC., a corporation organised and existing under the laws of the State of Texas, United States of America, of 850 Avenue H East, Arlington, Texas, United States of America.

THE PATENT OFFICE

105130/16

and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a shock absorbing sheet, by which we mean a sheet made of a shock absorbing material of the type which is normally used for making sheets for packing fragile articles. Examples of such articles are eggs, china, and glassware.

The underlying idea of the invention is to provide a shock absorbing sheet as herein defined which is suitable for use as a packing material and which is shaped in such a manner that the shock-absorbing properties of the material are enhanced.

According to the invention we provide a shock absorbing sheet of resilient material, both sides of which comprise alternate symmetrical protrusions and indentations with each identation on one side corresponding to a protrusion on the other, wherein at least the majority of the protrusions and indentations are shaped at their apices as segments of a sphere and elsewhere substantially as segments of a hyperbolic paraboloid, the material of the sheet being thinner at the apices of the protrusions and indentations than at the other parts of the sheet between the apices.

The sheet may be made from a foamed plastics material for instance expanded polystyrene.

The sheet material of this invention, although usable as a packaging material because it has considerable strength but yielding resiliency to absorbe shock and thus

[P]

taken in conjunction with the accompanying drawings. Of the drawings:

Figure 1 is a fragmentary semi-diagrammatic view illustrating a step in the manufacture of the sheet material of this invention;

Figure 2 is an enlarged fragmentary longitudinal sectional view through the co-operating portions of the sheet forming rolls;

Figure 3 is a fragmentary perspective view of a portion of a sheet material embodying the invention;

Figure 4 is a linear sectional view taken through the apexes of a plurality of adjacent convex and concave peaks of a portion of the sheet of Figure 3.

Because of the hyperbolic paraboloid structure of the sheet, particularly as modified to provide at least a majority of the peaks in the shape of a spherical segment, the resulting sheet is very resistant to deflection from externally applied forces. This rigidity of the design would make the sheet of little or no value for packaging fragile materials as the rigidity would transmit shock through the sheet to the article. However, the sheet of this invention overcomes this by being made from an inherently shock-absorbing material, which permits the sheet to absorb shock instead of transmitting it to the protected article, while the modified hyperbolic paraboloid design makes the sheet very resistant to crushing or other breaking.

In order to provide this rigidity of the

PATENT SPECIFICATION 1,118,607

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Int. Cl.:—B 65 d 1/36.

COMPLETE SPECIFICATION.

Improvements in and relating to Sheet Material.

We, AMERICAN EXCELSIOR, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 1000 North Halsted Street, Chicago, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a shock absorbing sheet, by which we mean a sheet made of a shock absorbing material of the type which is normally used for making sheets for packing fragile articles. Examples of such articles are eggs, china, and glassware.

The underlying idea of the invention is to provide a shock absorbing sheet as herein defined which is suitable for use as a packing material and which is shaped in such a manner that the shock-absorbing properties of the material are enhanced.

According to the invention we provide a shock absorbing sheet of resilient material, both sides of which comprise alternate symmetrical protrusions and indentations with each identation on one side corresponding to a protrusion on the other, wherein at least the majority of the protrusions and indentations are shaped at their apices as segments of a sphere and elsewhere substantially as segments of a hyperbolic paraboloid, the material of the sheet being thinner at the apices of the protrusions and indentations than at the other parts of the sheet between the apices.

The sheet may be made from a foamed plastics material for instance expanded polystyrene.

The sheet material of this invention, although usable as a packaging material because it has considerable strength but yielding resiliency to absorbe shock and thus resist breakage of fragile articles, may be used for other purposes such as decorative purposes where the embossing in the sheet adds to its attractiveness as well as its strength.

Other features and advantages of the invention will be apparent from the following description of one embodiment thereof taken in conjunction with the accompanying drawings. Of the drawings:

Figure 1 is a fragmentary semi-diagrammatic view illustrating a step m the manufacture of the sheet material of this invention;

Figure 2 is an enlarged fragmentary longitudinal sectional view through the co-operating portions of the sheet forming rolls;

Figure 3 is a fragmentary perspective view of a portion of a sheet material embodying the invention;

Figure 4 is a linear sectional view taken through the apexes of a plurality of adjacent convex and concave peaks of a portion of the sheet of Figure 3.

Because of the hyperbolic paraboloid structure of the sheet, particularly as modified to provide at least a majority of the peaks in the shape of a spherical segment, the resulting sheet is very resistant to deflection from externally applied forces. This rigidity of the design would make the sheet of little or no value for packaging fragile materials as the rigidity would transmit shock through the sheet to the article. However, the sheet of this invention overcomes this by being made from an inherently shock-absorbing material, which permits the sheet to absorb shock instead of transmitting it to the protected article, while the modified hyperbolic paraboloid design makes the sheet very resistant to crushing or other breaking.

In order to provide this rigidity of the

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sheet with internal resiliency the sheet preferably comprises a foamed plastics material. A particularly suitable plastics material for this purpose has been found to be polystyrene, although it is obvious that other foamed plastics having acceptable similar strength can be used.

Figures 1 and 2 of the accompanying drawings illustrate one form of apparatus that may be used to produce the sheet of this invention. As shown here, there are provided two driven rollers 10 and 11 each having spaced radially projecting pins 12 and 13 projecting outwardly from the outer surface. These pins have outer ends 14 and 15 of essentially hemispherical shape. The pins 12 and 13 are so spaced that a pin of one row exactly registers with the precise center of the area outlined by four adjacent area-defining pins on the other row. This cooperating of the pins is illustrated in Figures 1—3. With this relationship of the rolls and the pins a sheet 16 of foamed plastics material such as polystyrene passed between the rolls 10 is embossed as illustrated in Figure 3 with sets of four peaks 17 each with an apex 18 in the shape of a spherical segment produced by the hemispherical pin ends 14 and 15. Precisely centered between each set of four peaks 17 is a concave peak 19 also having an apex 20 shaped as a section of a sphere.

The sheet 16 is deformable, such as by being hot, before it is passed between the rolls 10 and 11. After being embossed as indicated by the pins 12 and 13 the sheet is chilled to set the embossed design. The sheet may be simultaneously heated and foamed.

The geometrical shape achieved between two adjacent pins of one row and two adjacent pins of the other row with the axes connecting each two sets of pins being at right angles to each other are of a modified hyperbolic paraboloid structure as shown in Figure 4. It is not, however, a true mathematical hyperbolic paraboloid which would continue indefinitely but is modified at each apex 18 and 20 to provide a special section caused by the stretching over the hemispherical ends 14 and 15 of each pin 12 and 13. As can be seen in Figure 4 the sheets at each apex 18 and 20 is somewhat thinner because of this drawing operation than it is at the sides of each peak 17 and 19.

The resulting sheet is therefore quite strong in resisting crushing, as there is provided a conformation of two geometrical shapes each of which has a very high strength to weight ratio and a high resistance to deflection by externally applied forces. Thus, although the sheet is quite thin, the combination of the hyperbolic paraboloid with its excellent load bearing characteristic and the section of the sphere shape of each apex or dome with its high strength to weight ratio and resistance to deformation provides an extremely strong sheet that maintains its strength even when the thickness of the sheet is quite small.

Thus, in both the section of the sphere and the hyperbolic paraboloid there are provided doubly curved surfaces which give rigidity and load bearing capacity that are much greater than could be expected in plain thin sheets. The sheet material of this invention can not ordinarily be deflected to any appreciable extent without actual crushing of the material. In order to provide cushioning and still achieve great strength, the plastics material of the sheet is internally resilient. A foam, as indicated diagrammatically at 21, is an ideal way of achieving this internal resiliency. The foam, being made of cells, gives enough resiliency to the sheet so that it will absorb shock to a considerable degree rather than transmitting it to the packaged article. Thus, the individual bubbles making up the foam can yield and deflect under shock and cushion the load. At the same time the above described geometrical shape of the sheet permits it to recover rapidly from shock and makes it quite resistant to being crushed.

Although in the illustrated embodiment the pins 12 and 13 are so arranged that each combination of four adjacent pins on the same roll describe a square, they could obviously be positioned to define a rectangle, a diamond or any other such four angle quadrangle.

When the sheet 16 passes between the rolls 10 and 11 the sheet is in effect stretched from both sides over the oppositely located series of pins. That is the reason that with respect to either side there are provided convex and concave peaks having the geometrical structure previously described. As the sheet passes between and is embossed by the pins it is stretched beyond its elastic limit so that the sheet retains the indented form on emerging from the rolls as indicated at 22 in Figure 1.

Another reason why synthetic plastics material is very efficient for forming the foam sheets of this invention is that the deforming of the sheet and the drawing between the pins when the sheet is hot actually adds considerable strength to the sheet. This is true because as the heated sheet is stretched by the pins as illustrated by the variations in thickness in Figure 4 the polymeric molecules tend to slip past each other as the elastic limit of the sheet is exceeded. As this is done at an elevated temperature when the sheet is in a plastic condition the bonds between the molecules are not weakened but are actually strengthened once the sheet is returned to room temperature.

Having described my inention as related to the embodiment shown in the accompanying drawings, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its scope as set out in the accompanying claims.

WHAT WE CLAIM IS:—

1. A shock absorbing sheet of resilient material, both sides of which comprise alternate symmetrical protrusions and indentations with each indentation on one side corresponding to a protrusion on the other, wherein at least the majority of the protrusions and indentations are shaped at their apices as segments of a sphere and elsewhere substantially as segments of a hyperbolic paraboloid, the material of the sheet being thinner at the apices of the protrusions and indentations than at the other parts of the sheet between the apices.

2. A sheet according to claim 1 wherein the resilient material is a foamed plastics material.

3. A sheet according to claim 2 wherein the foamed plastics material is expanded polystyrene.

4. A packaging material in the form of a structural sheet according to any of the preceding claims.

5. A shock-absorbing sheet substantially as herein described with reference to the accompanying drawings.

WITHERS & SPOONER,
Chartered Patent Agents,
148—150, Holborn,
London, E.C.1,
Agents for the Applicants.

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from which copies may be obtained.

1118607 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig. 1

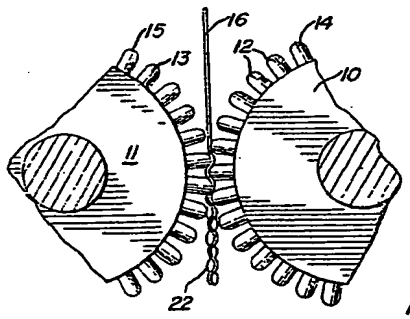

Fig. 2

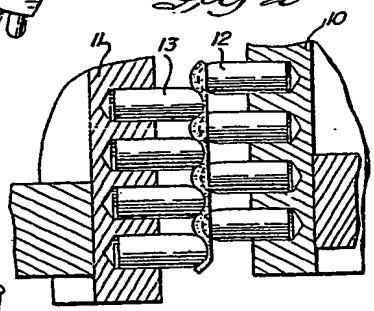

Fig. 3

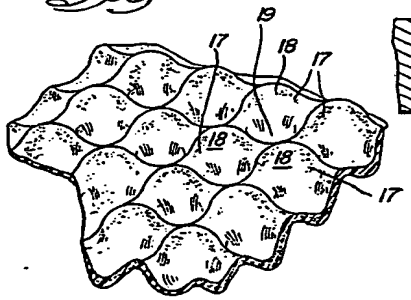

Fig. 4